AN
ESSAY
ON
ELECTRICITY:

Being an ENQUIRY into the
NATURE, CAUSE and PROPERTIES thereof,
On the PRINCIPLES of
Sir *Iſaac Newton*'s THEORY
OF
VIBRATING MOTION, LIGHT and FIRE;
And the various *Phænomena* of Forty-two
CAPITAL EXPERIMENTS;
With ſome
OBSERVATIONS relative to the USES
That may be made of this Wonderful
POWER *of* NATURE.

By *BENJ. MARTIN.*

> *We Mortals have not yet learn'd all Things of Jove; many Things hitherto remain hidden; of which ſome, when it ſhall pleaſe him, he will give us in Futurity to know.*
>
> Arat. Solenſ. Phænom.

BATH,
Printed for the AUTHOR; and Mr. LEAKE, and Mr. FREDERICK, Bookſellers; Mr. RAIKES, Printer, at *Glouceſter*; Mr. COLLINS, Printer, at *Saliſbury*; and Mr. NEWBURY, Bookſeller, at the *Bible and Sun* in St. *Paul's Church-Yard*, *London*. M.DCC.XLVI.
[Price *Six-Pence*.]

PREFACE.

I Had no Thoughts of a Preface to this ſmall Pamphlet, 'till juſt as the laſt Page was printing, I was inform'd by the Papers of a Piece of the ſame Kind juſt publiſh'd, by Mr. *Freke*, F. R. S. I immediately procured, and peruſed it; expecting to ſee the ſlight Pains I had taken to account for Electrical *Phænomena* quite fruſtrated; not that I had any Miſgivings about any reaſoning founded upon the irrefragable Topics of the *Newtonian* Theory, and the Suffrage of ſo many obvious and demonſtrative *Experiments*. But when I conſider'd the Force of an *Honorary Title*, and the Approbation of a Perſon *moſt juſtly diſtinguiſhed for his ſuperlative Underſtanding in all Natural Knowledge*, I began to think of the hard Fate of my Bookſellers, and to ſay in Myſelf, *Actum eſt de me.*

But before I had read to two Pages, I recover'd my Spirits; and upon reading on, my great Concern for Myſelf and my own Book, ſoon began to change for the Author and his. When I found him endeavouring to prove,—*That the Electric Fire is not produced from the Globe by Friction*;—*That it is contain in, and ground from the Air*, (like Corn from the Hopper in a Mill;)—*That it moves ſpirally round the Globe, or Tube*;—*That Bees-Wax and Silk are a* Caput Mortuum;—*That Electricity forms a* Capſula *covering the Electrified Body, and pervading every Part and Particle thereof*;—*That it conſtitutes a Vortex of a Whirl-Pool of Fire*;—*That Sounds are occaſion'd by*

a

a *Modification of Air*;—*That the Cracking of a Whip is cauſed by breaking the Continuity of the Air*;—*That the Electric Virtue darts with Repercuſſion, or infinite Recoil*, &c. &c. &c. I ſay, upon reading a Syſtem of ſuch Kind of Conjectures and Theſes as theſe, I could not help having ſome Commotion and Commiſeration for the Author; who ſeems to me to have no more Notion of the Nature and Cauſe of *Electricity*, than he has of the Elements of *Modern Philoſophy*. It would be a great Wonder, indeed, if ſuch wild Reveries, as are contain'd in that Book, *ſhould eſcape the Cenſure of ſome who ſet up for Criticks*; but I think it will hardly be worth their while *to try their Hands to condemn it*; the Performance appearing too plain a *Felo de ſe*. Sir *Iſaac* has too many Opponents, 'tis true; and I am ſorry this Author ſhould prove to be one of them; for I take it, that forſaking Sir *Iſaac*, is as bad, if not worſe, than oppoſing him; and I look upon Error in Philoſophy to be hurtful. But Truth is ſtill ſafe, and will be triumphant, (notwithſtanding all the Cant of *Elementary* Fire,) according to *Eſdras*,

Magna eſt Veritas, et prævalebit.

AN ESSAY ON ELECTRICITY, &c.

AS the Power and various Phænomena of Electricity, which of late have been invented and exhibited in Experiments, have greatly amuſed Mankind, and juſtly raiſed their Wonder and Surprize, it is but natural to expect they ſhould appear very anxious about the Cauſes thereof, or Manner of accounting for it; and alſo extremely inquiſitive concerning the Uſes that may be made of ſuch an amazing Efficacy.

As to the Firſt of theſe Particulars, *viz. The Cauſe of Electricity, and the Manner of account-*

accounting for its Effects, there have been many Hypotheſis form'd to ſolve them; but they have been chiefly invented by Men, who have appear'd to underſtand little or nothing of true Philoſophy; or elſe to have been ſo affected with Novelty and Singularity, that the Principles they advance are more doubtful and myſterious than the Cauſes and Properties of the Electric Virtue they account for by them. We hear People conſtantly debating on this Head, as if Sir *Iſaac*, and his Philoſophy, had never been heard of, or read.

For my own Part, I have been always perſwaded we ſhall never arrive at the Cauſe of Electricity, unleſs we purſue our Enquires by the Clue given us by that Great Man. That is to ſay, the Nature, Cauſe, Properties, and Effects of Electric Virtue, are explicable only on the Principles of the *Newtonian Doctrine of Light and Fire*. This is therefore, in the firſt Place, to be premiſed, and which I ſhall lay down under the following Heads, *viz.*

Firſt, We find by Experience, that the Parts of all Bodies when agitated to a certain Degree, do ſo act upon Animal Bodies as to excite the Senſation of *Warmth* or *Heat*.

Secondly, Such an Agitation or inteſtine Commotion of the Parts of Bodies may be effected by various Means; as Friction, Percuſſion,

cuſſion, Fermentation, Vital Motion, the Action of Light, *&c.*

Thirdly, THE *Standard Degree of Warmth or Heat*, is that of an Animal Body; or in other Words, if the Parts of any Body have a greater Motion than the Parts of the animated Body, as the Hand, we ſay it is *warm* or *hot*; but if they have leſs Motion than thoſe of the Hand, we ſay they are *cold*. Laſtly, if the Motion of the Parts are the ſame in both, we then ſay, ſuch a Body is neither hot or cold. And hence it appears, that the Ideas of Heat and Cold are only in a comparative Degree.

Fourthly, THE Parts of Bodies when agitated, or heated beyond a certain Degree, emit or throw off ſuch fine ſubtle Particles, or *Effluvia*, which *ſhine* or excite the Idea of *Light*; and which therefore we generally call *Particles of Light*.

Fifthly, WHEN the Parts of the Body are ſo violently agitated, that they not only throw off lucid Particles, but alſo ſhine themſelves, then we ſay, it is a *Body of Fire*, when the Particles are not in a *fuming State*; but when they are, we call that lucid Fume a *Flame* of Fire.

Sixthly, THE Intenſity of the Action of ignited Bodies depends as well on the Denſity, as the Velocity, of the Parts; and when both theſe are in an extreme Degree, the *Momentum*, or whole Force of the Heat becomes intolerable, and inconſiſtent with the State of a natural Body; and its Action is, in this Caſe, what we call *Burning*.

Seventhly, THERE are ſome Caſes where the Parts may have ſufficient Velocity to appear *lucid*, but not be denſe enough, at the ſame Time, to *burn*.

Eighthly, THE Motion with which the Parts of Bodies are thus agitated to emit Light, and Heat, is of the vibrating Kind; becauſe the Motions and Directions of the Particles in this Caſe may become uniform, conſonant, and harmonious; and all conſpire to produce the Effects which they could not do by a confuſed contrary Motion of Parts.

ON theſe Principles Sir *Iſaac Newton* accounts very clearly for many of the wonderful Phænomena of Nature, eſpecially of the *Phoſphoreal* and *Electrical Kinds*. For Inſtance; the Shining of Sea-Water in a raging Storm; of Quick-Silver agitated in Vacuo; of Wood, Fleſh, and Fiſh, by Putefraction; the *Ignes Fatui*; of Stacks of Corn, Hay, *&c.* by Fermentation, growing wet, and firing; the Glowing of ſome Worms, Inſects, and Eyes of Animals, by vital Motions; of *Phoſphorus*, by Attrition, or the Action of the acid Particles of Air; of Iron hammer'd very nimbly, 'till it becomes red-hot; of the melted Parts of Steel ſtruck off by a Flint; of Axle-Trees fired by the rapid Rotation of the Wheels; and of the Mixture of ſome Sorts of Fluids, producing great Heat, Accenſion, and Exploſion.

But moſt expreſly and largely, he applies this Theory to a General Explication of the Production of Electricity. He tells us, the Glaſs Globe, by Attrition with the Hand, will ſhine, and emit ſuch an Electric Vapour, as by ſtriking againſt Paper, Cloth, or the Finger, will be put into ſuch an Agitation as to emit Light, and make the Paper, *&c.* appear lucid, like a Glow-Worm; and in ruſhing out of the Glaſs, it will ſometimes puſh againſt the Finger, ſo as to be felt. Thus far Sir *Iſaac*.

The above *Theory of Light and Fire* will, I think, be nearly ſufficient to ſolve all the Phænomena of Electricity; which I ſhall enumerate in Order as follows.

Phænomena I. The *Electric Virtue* conſiſts in a fine ſubtile Matter, omitted from ſome Sorts of Bodies under the Circumſtances of Attrition, which Bodies are call'd Electrics *per ſe*.

Phænom. II. This Virtue will not be excited in ſome Sorts of Bodies, which therefore are call'd Non-electrics.

Phænom. III. This Virtue repels all Light Bodies lying on the Surface of that in which it is excited, which is term'd the *Electrized Body*.

Phænom. IV. THIS Virtue attracts all Sorts of light Subſtances within the Space of its Action, and then repels them again from the Electrized Body.

Phænom. V. IT ſuffers not the Body once repell'd to approach the electrized Body, 'till it has firſt touch'd ſome other Body; and then it will again attract it.

Phænom. VI. THIS Virtue will run off upon, or be received by all Non-electric Bodies; but will be refuſed or reſtrain'd by all Electrics *per ſe.*

Phænom. VII. THIS Virtue, when excited to a ſufficient Degree, appears *lucid*, and ſhines in the Dark like a Flame.

Phænom. VIII. IT is emitted with great Velocity, attended with a *Snapping*; or ſmall, but fierce Exploſion.

Phænom. IX. THE Eruption of Electric Fire to a Non-electric Body, condenſes the ſaid Fire; and as this Fire is in a leſs or greater Degree, it appears of a bluiſh Purple, Yellow, or White Colour.

Phænom. X. IT runs thro' any Length of a Non-electric Body almoſt inſtantaneouſly.

Phænom. XI. It kindles any inflammable Vapours or Fume, and thereby ſet the Body on Fire that emits it.

Phænom. XII. All the Properties and Effects of the Electric Virtue appear to be nearly the ſame, at any Diſtance from the Body in which it was firſt excited, and having paſs'd thro' any Number of intermediate Non-electric Bodies.

These are the Principal Phænomena of Electricity, which we now proceed to give ſome Account of from the Principles of the above-mention'd Theory. As to the Firſt, there can be no Doubt of the Exiſtence of ſuch a ſubtle Matter in the Subſtance of Bodies, or of its Emiſſion or *Effluvium*, becauſe it can be ſo eaſily demonſtrated to the Senſes by Experiments.

This ſubtle Matter, or Spirit, appears to be of an Elaſtic Nature, and acts by the Reciprocations of its Tremours, or Pulſes, which are occaſion'd by the vibrating Motion of the Parts of an Electric Body, excited by Friction. Hence as *Friction* is neceſſary to excite a vibrating Motion in the Parts of Bodies, in order to throw off the Electric Matter; it follows, that thoſe Bodies, whoſe Parts, by Friction, will not conceive a Vibration, or be put into a uniform reciprocating Motion, will not prove Electrical, or be productive of Electricity: And the Defect ſeems to ariſe from the Want of a natural Elaſticity of the Particles of the Body. Thus the White of an Egg in its natural State, or boil'd to a greater Conſiſtence, is a Non-Electric; but when it is thorough dry and hard, it is then as Brittle and Yellow, and as Electrical as Amber itſelf.

NOR is it any Thing leſs than the higheſt Degree of Elaſticity in Bodies that renders them capable of thoſe Vibrations which put the Electric Matter into Action. For we obſerve the White of an Egg boil'd, and the ſtrongeſt Glues, when cold, are conſiderably elaſtic, yet are utterly Non-electrical; even temper'd Steel itſelf, tho' ſo greatly elaſtic, ſhews no Signs of Electricity. In ſhort, nothing leſs than that Degree of *Elaterium*, which makes Bodies brittle, and break with a Poliſh, as in Glaſs, Amber, Roſin, Pitch, Wax, *&c.* will conſtitute them Electrical.

THE Electric Matter, as it is emitted from the Body, enters into, and poſſeſſes every light Non-electric Body it meets with in its Way, and carries it by Impulſe in its Direction, *viz.* from the Electric Body, this we call the *repulſive Power* of Electricity. This Electric Spirit having impregnated the light Body, and wholly poſſeſs'd it, begins there to form a new Sphere of Action, or Vibration; whoſe Pulſes being in a contrary Direction to thoſe of the Electrical Body, will cauſe the ſaid light Body to keep every where beyond the Sphere of its Activity, or to be conſtantly repel'd by it. This is very evident by Experiment.

Hence it is, that when two or more Bodies are poſſeſs'd of the ſame Power, at the ſame Time, they always repel each other; ſo the *Plumulæ* of Feathers, while the Electric Virtue is among them, repel each other. Thus it is alſo in *Magnetics*; two Needles touch'd on the ſame Pole of a Load-Stone, repel each other, if put together by their touch'd Ends on the Surface of Water, or ſuſpended on the Points of Needles.

Hence alſo it is, that the Electrical Virtue will not run off the electrified Body to another which is an Electric *per ſe*; for tho' an Electric Body, in order to emit this Virtue very copiouſly, muſt be excited by Friction; yet we are to underſtand, that all Electrics *per ſe* have naturally a vibrating Motion of the Parts, by which they emit this Virtue in a leſs Degree, and imperceptably; and ſo have each a proper Sphere of Action; and the Pulſes of each Sphere being in contrary Directions, cannot conſpire and unite, but muſt reſtrain and cohibit each other. Thus the Flame at the End of the Iron, at the Approach of a *Match*, retires, and ſeems repel'd by the contrary Action of the *Brimſtone*, while it is greatly dilated at the diſtant Approach of the Finger, and ruſhes againſt it with a Blaſt. Thus alſo is in Magnetics *per ſe*; for two

Loadſtones placed on the Water in Baſons, or ſuſpended by Strings, with their two ſimilar Poles together, will always repel each other. Therefore it is, that when we would conduct or communicate the Electric Virtue to any great Diſtance by the Mediation of any Non-electric Body; the ſaid Body is either ſuſpended by *Silken* Strings, which are electrical, or laid on *Cakes of Roſin*, that the Virtue might not run off thereby.

THE Electric Virtue in that Part of its Vibration, by which it returns to the excited Body in each Pulſe, meeting with light Bodies in its Ways, impels them forcibly towards the Electric Body, and makes them appear to be attracted by that Body; and ſo this is call'd the *attractive Power of Electricity*. But here it may be remarked, that Electric Bodies, if Light, as well as others, are attracted; true, they are, but then they are not excited, and their natural Vibration, or Action, being very weak, will be overcome by the Power of the excited and ſtronger Electricity, and ſo carried or moved in its Direction. It may likewiſe be farther objected againſt, what I advanced above, that the natural Efficacy of the Silken Strings ſhould be too weak to reſtrain the excited Electricity from entering its Subſtance, and running off by it; but to this I anſwer, in the Silk there is naturally a Sphere of Action or Vibration; in the Electricity of the electrified Body there is none, 'till it begins to be emitted from the Extremity, or ſome other Part; all the Motion that it has in the electrified Body being that which it firſt received from the excited Body, and is continued and propagated in the electrified Body by the natural Vibration of its Parts, which is weaker than that in the Silk, and therefore it muſt paſs on by it, to make its Exit at the End.

As to the *Lucidity* of the Electric *Effluvia*, nothing more is requiſite thereto, but a certain Degree of Velocity, which is eaſily produced by Attrition, according to Article 4th of the Theory.

In order to account for the Snapping or Exploſion of the Eruption of the electric Fire, it is to be obſerved, that this Exploſion, like all others, conſiſts in a violent Concuſſion of the Air, by a ſudden Expanſion and Burſting of the denſe Stream or *Profluvium* of the Fire, in ſtriking againſt the Non-electric Body. Yea, ſometimes it will ſnap againſt, or in the Air only, as when it ruſhes out of the Mercurial Phial thro' the Pores of Sealing Wax. Now this Exploſion muſt ariſe from that violent Action among the Electric Particles which proceeds from the extreme Degree of Velocity that conſtituted a denſe Body of liquid Fire, (for it never ſnaps but in ſuch a Caſe) and by that Action, as it becomes more denſe, it becomes elaſtic; and at length, by daſhing againſt the

Surface of any Body, it is more and more condenſed, and the innate Elaſticity ſo far increaſed, as to cauſe it to burſt, explode, or flaſh away in an inviſible Vapour. And perhaps, this more adequately than Gun-powder itſelf, repreſents to us the true Caſe of Lightning and Thunder; nor can we here ſuppoſe the Effects of Sulphur excluded; for as moſt metalic Subſtances, ſo Iron in particular, contains a great Admixture of Sulphur; now ſome of thoſe ſulphureous Particles, may, by the intenſe Action of the Electric Fire, be diſſolved and carried with it into the Air, where the Nitro-acid Particles may conduce to the Accenſion, and promote the Exploſion we are ſpeaking of. And hence it may be, that the Communication, Action, and Exploſion from Iron Subſtances are much more conſiderable than can be produced from any other.

Where the Electric Fire is not ſo much condenſed as to ſnap, or explode, it goes off in a large dilated Stream of Purple Flame, and greatly reſembles the Corruſcations of the *Aurora Borealis*, eſpecially that Part of the *Aurora* which appears in a conſtant ſtreaming Light.

When the Electric Fire is but a little denſe, it appears of a bluiſh Colour, as all other faint Lights do; thus the Moon-Light, which is extremely weak, appears blue in Candle-Light:

And when the ſaid Fire is a little more denſe, it appears of a purple Hue, and has a greater Effect; a ſtill greater Denſity makes it look Yellow, like Candle-Light; but the greateſt Denſity is ſhewn by a yellowiſh White, like the Sun's Light, and then it produces the greateſt Force of Exploſion and Percuſſion. As yellow Lightning vaniſhes in an innocent Flaſh; but white and denſe Lightning produces terrible Effects. So alſo *Phoſphorus*, while agitated by a gentle Friction, ſpends itſelf in a lambent innoxious blue Flame; but when its Action is highten'd by a greater Attrition or Contuſion, it kindles into a white Flame, and burns with an outrageous and unquenchable Fire. Therefore the Phænomena and Effects of Electricity, Lightning, and *Phoſphorus*, ſeem to be of an homologous Nature, and to have ſomething that is eſſential and common to each.

THAT the Electric Fire ſhou'd ſhew itſelf, and produce its Effects at any indefinite Diſtance from the excited Body, is nothing ſtrange or unaccountable, when we conſider it as a propagated Fire, and of a ſimilar Nature to Lightning; for Fire of this Sort looſes nothing, but rather is increaſed by its Propagation, with Reſpect to its Efficacy. As Lightning pervades ſoft and yielding Subſtance unhurt, and proves the Diſſolution only of hard and compact Bodies; ſo Electricity is not felt in the ſoft and muſcular Part of the Body, but ſtrikes the harder Bones with a benumbing Shock. And as thoſe denſer Parts of Lightning which we call (Thunder-Bolts,) ſtrike againſt hard Bodies, and glance by Reflection to different Parts; ſo the Fire of Electricity ſtriking againſt the lower Part of the *Humerus*, at the Elbow of one Arm, ſeems reflected from thence acroſs the Breaſt to the Elbow of the other Arm, and from thence flies out of the Body, if nothing be near it; but if ſeveral join Hands, it is almoſt inſtantaneouſly reflected from one to the other, though the Arms and Elbows of the whole Company, be they ever ſo many. Laſtly, as Lightning does inſtantly deprive an Animal of Life, by its deleterious Stroke, when ſufficiently denſe; ſo the Electric Emanation may be ſo condenſed, and its Force ſo encreaſed, as to ſtrike a Bird quite ſenſeleſs, and ſometimes quite dead, in a Moment. The Parallel might be carried yet further, between Lightning and Electric Fire; but I have not Room to enlarge.

Thus I have propoſed what I have to ſay, for a Solution of the ſeveral *Phænomena* of Electricity; for the moſt Part of which I have the Authority of an excellent Theory, and the Suffrage of a great many explicit and demonſtrative Experiments, which I have ſubjoin'd for further Satisfaction and Entertainment of the Reader. Theſe Experiments are ſuch as I daily ſhew in my Courſe of Philoſophy, and are therefore indiſputable Facts, and Topics of Argumentation.

But, now I am reduced to the arduous Taſk of anſwering this very common and important Queſtion; "*What is the Uſe of this moſt wonderful and ſurprizing Property of Bodies?*" Not but that my Anſwer is very ſhort; and if it were to be but once or twice repeated, would be very eaſy, *viz. That at preſent I know ſo little of its Uſe, as not to be able to form any rational Conjecture about it.* What we know of this Kind muſt be diſcover'd by Experience. And as I am fully perſwaded all the Powers of Natural Bodies were deſign'd to anſwer very great Purpoſes, yet what they are, are not diſcover'd to us all at once, but by ſlow Degrees. True Philoſophy was but dawning fifty Years ago; and can we think it ſtrange that any Thing ſhould yet appear abſtruſe or difficult to account for? I rather wonder we have been able, in ſo ſhort a Time, to diſcover ſo much relating to the Uſes that may be made of it. As for Inſtance, the Analogy between the Fire of Electricity and Lightning; between its Snapping and Thunder; between their Forces and Effects on Animal Bodies, and Animal Life; between Electricity and common Fire, in reſpect of Velocity and Combuſtion; between Electricity and Phoſphorous, in Regard of its various Degrees of Light, Colour of Light, and Manner of Burning. Moreover, we know it has a conſiderable Influence on Fluid Subſtances: A glaring Inſtance is that of the Syphon, and Sponge; by which it appears, that Fluids in Motion, have their Motion greatly accelerated by the Electric Virtue. Thus if a Vein be open'd in a Perſon electrified, the effluent Blood will project to a much greater Diſtance, than it would otherwiſe do: And is not this a promiſing Indication of ſome great Uſe that may be one Time or other derived to the Animal Œconomy from Electricity?

YEA, further, I know from my own Experience, that different Perſons are affected by the Electric Virtue in a very different Manner; ſome prove extremely electrical, others very little ſuſceptible of it; and it has been found that a Perſon poſſeſs'd with the Infection of the *Small-Pox*, could by no Means be electrized at all; Theſe are early and intereſting Diſcoveries, and plainly intimate this wonderous Efficacy was intended for ſomething more than meer Amuſement to Mankind. What Relation it has to the *Animal Spirits*, or that which we mean by that Term, in *Animal* Bodies, I know not, but muſt leave to older and wiſer Heads to determine by a longer Courſe of Experiments. What I have ſaid, I ſubmit to the Judgment of thoſe whoſe Province it is to apply the Diſcoveries of Natural Philoſophy, to the Utility and Benefit of Mankind. My Buſineſs is chiefly to make the Experiments, which I ſhall now proceed to deſcribe in all their proper Circumſtances, as they are perform'd on a Machine, conſiſting of a large Wheel and Glaſs Globe, or Spheroid, fix'd in a large long Frame of Wood, made in moſt Reſpects like that of Mr. *Monnier*, but more eaſy in Operation, by Means of *Friction Wheels* on which the Axle of the great Wheel turns; the Reſt of the Apparatus will be mention'd in the Sequel of the following EXPERIMENTS.

EXPERIMENT I.

ON the Axis, in the Center of the Globe, is fix'd a circular String of Threads, at ſmall Diſtances from each other; and when the Globe is at reſt they all hang down by their Gravity; but when the Globe is put in Motion, and a little heated, they all extend themſelves from the Center to the Circumference, or inner Surface of the Globe, which they very nearly touch, in right-lined Directions, ſo as nearly to repreſent the Spokes of a Coach-Wheel. This they do by the Electric Virtue acting ſtrongly upon them from the inner Surface of the Globe. And in this Condition they will continue, 'till the Virtue ceaſes, and the Globe becomes cold, when they gradually fall down, and take the firſt perpendicular Directions.

Exp. II.

THE Globe being whirled round, and the Threads expanded as before, if the Hand or any Non-electric Body be moved towards the Surface of the Globe, the Threads within will ſeem immediately ſenſible thereof; and, as if animated thereby, will, in a very wonderful Manner, move every Way to the Hand, by a Motion like that we obſerve in the Legs of a Spider, eſpecially that Sort we call a *Carter*, or *Father Long-Legs*. By this Experiment we obſerve the ſurprizing Nature and Subtilty of this Kind of *Effluvia*, as it is ſeen to penetrate and pervade the Subſtance of Glaſs with the ſame Readineſs and Freedom as if nothing were in the Way to intercept it.

Exp. III.

A Hoop of fine Threads being placed any how about the Globe in Motion, will have all the Threads drawn out of their natural perpendicular Directions into others which paſs thro' the Center of the Globe, and ſo will be all perpendicular to the Surface, which makes a very pleaſing Spectacle. By this Experiment it appears, that the Electric Virtue acts equally both within-ſide and without the Globe, and in Directions perpendicular to its Surface.

Hence alſo we ſee the Power of Electricity is greater by far than Gravity with us.

Exp. IV.

THE Hoop of Threads remaining about the Globe in Motion, as in the laſt Experiment, if the Room be darken'd, the Ends of the Threads on the Outſide of the Globe will be all tip'd with Fire, and make a beautiful Apparition of Stars; Which ſhews, that the *Electric Virtue* is a fine thin bluiſh Flame of Fire, much like that of Phoſphorus gently rubb'd in the Dark. The Threads within exhibit no Appearance of Light; which ſhews, that this Virtue acts only outwardly, and by that Means the Threads within are drawn towards the Surface.

Exp. V.

A long, pointed, Piece of Iron being laid on a Frame of Silken Strings, with one End about a Quarter of an Inch from the Globe, will, at the other End, (which terminates in a conical Point) emit a Purple Flame of electrical Fire, diverging each Way from the Point, like the Rays of the Sun from the Focus of a Burning Glaſs in a darken'd Room. This Pencil of electric Rays is viſible even in the Day-Light, but is extremely ſo in the Room made dark; and if the Finger be held within a Quarter of an Inch, it cauſes the Fire to iſſue out in a greater Quantity, and to appear much more luminous than before.

Exp. VI.

THE Finger being placed as above directed, within a Quarter of an Inch of the ſaid Flame, will be ſenſible of a gentle Blaſt of Wind from the End of the Iron, that is, the Electrical Fire will iſſue out of the Point in ſuch a Manner, as to blow againſt the Finger very ſenſibly; and if the Finger be held ſtill nearer, the large Pencil of Rays will be condenſed in ſuch a Manner as to run out of the Point upon the Finger in a Stream, or Body, of denſe yellow Fire, and ſtrike the Finger like a gentle *Jet d'eau*; and indeed the Phænomenon may be truly call'd a *Jet de Feu*. This Electric Flame alſo is ſenſible to the Smell, and much reſembles, in that Reſpect, the Fire of *Phoſpharus*.

Exp. VII.

IF, while the Flame continues to appear from the Point of the Iron, the Finger be placed any where upon the Iron, the Flame at the End diſappears immediately; if the Finger be taken off, it again does inſtantly appear; and ſo by putting the Finger off and on ſucceſſively, the electric Flame will appear and diſappear alternately. The Reaſon whereof is, that when the Finger is applied, the Electric

Virtue all runs off upon the Finger, as a Non-electric Body, and therefore cannot go to the pointed End to produce the Flame, as it does when the Finger is taken off.

EXP. VIII.

IF a Muſket-Barrel be ſuſpended, and the Finger applied near it, (as within $\frac{1}{5}$ of an Inch) the Fire will forcibly iſſue out, and ſtrike it, and in ſtriking it will give a very ſenſible Snap; and ſeveral Fingers being ſucceſſively applied to the Barrel, will cauſe ſeveral ſuch Erruptions and Snappings of the Fire, which will be all very ſenſible to the *Feeling*, to the *Eye*, and to the *Ear*; and produce a moſt extraordinary and entertaining Phænomenon.

EXP. IX.

IF a *Chain*, or *Hempen-Cord*, be ſuſpended by Silken Strings, all round the Room, of any Length you pleaſe, and one End thereof be hung by a Loop acroſs the Barrel, the Electrical Fire will inſtantly be tranſmitted thro' the whole Length of the Chain, and appear upon every Part at the Approach of the Finger, and be heard to ſnap, and ſtrike with as great, if not greater, Force, than from the Gun-Barrel itſelf. In this Particular, the Electric Fire ſeems ſomewhat a-kin to that of *Lightning*.

Exp. X.

IF a Feather be ſuſpended by an Hempen or Flaxen Thread, or String, it will, when held near the Barrel, be ſtrongly attracted thereby, and adhere immoveably thereto; becauſe all the Electricity goes away, or runs off thro' the Non-electric Bodies, with which the ſaid Feather communicates. But the Manner how the Feather can be attracted by a Virtue or Power acting outwardly, and in contrary Directions may ſeem ſomewhat ſtrange, yet is accounted for by the foregoing Theory.

Exp. XI.

THE ſame Feather, or any Light Body, ſuſpended near the Gun-Barrel by Silken String, will be firſt attracted by it, and then ſoon afterwards repell'd; and will continue to be ſo repell'd 'till it has touch'd ſome other Body. The Reaſon of this is, that upon the Contract with the Barrel, the Feather is impregnated with the Electric Virtue, which will not run off upon the Silken String, as being an Electric per ſe. Now it is found to be the Caſe of all attracting Powers, that Bodies equally poſſeſs'd with them always repel each other, unleſs they are either in immediate Contact, or very near it. But when the Feather has touch'd ſome Non-electric Body, it looſes its Electricity, and again becomes capable of being attracted.

Exp. XII.

IF the Silken String by which the Feather is ſuſpended be wetted throughout its Length, it will become a Non-electric Body; and the Feather, inſtead of being attracted and repell'd, will now be only attracted. For all the Electric Virtue runs off by the Moiſture of the Thread: By which it appears, that Water, or any Kind of Moiſture, is a Non-electric Subſtance, and ſo a Conductor of Electricity. Hence it is, that in a moiſt Air, the Feather in its repell'd State will, by Degrees, looſe all its Electricity among the aqueous Particles, and will then again return to the electrized Barrel, by Attraction.

Exp. XIII.

IN like Manner, a Card, or Tin-Plate, being fitted into the End of the Barrel, if any light Bodies be laid thereon, (as Leaf-Gold, Silver, or Braſs, *&c.*) they are immediately repell'd, as if blown away with a Blaſt of Wind; nor will they come near the Barrel, or Plate, again, 'till they have firſt diſcharg'd their Electricity on ſome Non-electric Bodies.——*Note*, While the Globe is whirling round, ſome Perſon ſtanding by muſt lay his Finger over the Barrel, to prevent the Electric Virtue going to the light Bodies, 'till the appointed Moment, when, upon taking off the Finger, they all fly off at once.

Exp. XIV.

IF under the ſaid Plate you hold another, with the ſame light Bodies upon it, they will be attracted and repell'd alternately between the two Plates, in a very entertaining Manner, and with a very great Velocity, and for a conſiderable Time. The Reaſon why they are attracted a Second, Third, *&c.* Time, is becauſe each Time they are repell'd back to the lower Plate, they looſe upon it all their Virtue, and ſo become again attractible.

Exp. XV.

IF a large plumy Feather be ſuſpended horizontally at the End of a long Chain, communicating with the Barrel, and another ſet upright under it, on a Cork, in a Glaſs Phial upon a Pedeſtal; then when the Finger (before laid on) is taken off the Barrel, 'tis very pleaſant to ſee how the Electricity coming among the *Plumulæ*, or Fibres of the ſuſpended Feather, will cauſe them to extend and expand themſelves every Way from the Rib of the Feather, at the ſame Time they will attract the Feather beneath, and cauſe its Fibres to raiſe themſelves, and briſtle out in the ſame Manner. Here 'tis obſerveable, that all the *Plumulæ* repel each other, and therefore ſtand at an equal Diſtance nearly; and this they do, as being all poſſeſs'd of the ſame Virtue, which cannot go off, becauſe of the Glaſs Phial, which is an Electric *per ſe*.

Exp. XVI.

WHILE the Feathers are in their repellent State, if any one lays his Finger on the Barrel, or any Part of the Chain, it is beautiful to ſee how inſtantly the Feathers are ſenſible of it, by letting their Plumage all fall and drop into their natural State. As alſo if he but ſlightly touches the Barrel, or Chain, the Feathers ſuddenly catch, and ſhrink in, like the *Senſitive Plant*; and hence, by the Way, ſome think the Phænomena of that Plant are owing to the repulſive Power of Electricity between the Finger and its Leaves.

Exp. XVII.

IF while the Feathers are electrized a Perſon approaches his Finger near them, (eſpecially that which is ſuſpended) they will immediately point all their *Plumulæ* towards the Finger, and be ſtrongly attracted by it; and if the Finger touches the Feathers, they all ſeem eager to embrace it, and are ſtrongly attached thereto; if the Hand be moved round about the ſuſpended Feather, the Feather will nimbly turn after it, and every where endeavour to lay hold on it; which, when it does, it looſes all its Electricity, and again becomes Non-electric.

Exp. XVIII.

IF to a Gun-Barrel you adapt a ſmall Tin Cup, and pour in Water; then a Perſon holding his Finger perpendicular over the Water, and within a Quarter of an Inch of its Surface, or leſs, will find the Water riſe up in Form of a Cone to meet his Finger, and from the Vertex or Top thereof, a little Stream of Fire will iſſue to the Finger, and ſnap againſt as uſual, tho' not with ſo much Force as from the Sides of the Pot or the Barrel itſelf. It is obſerveable, that neither the Water nor any other Body will be in the leaſt ſenſibly heated by all the Electric Fire they are capable of receiving. Whence it appears, that this Fire is not ſufficient to put the ſmall Particles of Bodies into ſuch a Vibration or Agitation, as to excite the leaſt Senſation of Warmth or Heat.

Exp. XIX.

IF a Sponge, thorough dry, be hung on to the electrified Barrel, it gives no Appearance of Fire, which ſhews it to be an Electric Subſtance: But if when the Sponge has been immerſed in Water, it be ſuſpended to the Barrel as before, and the Finger or Hand be applied near to it, the Fire iſſues out with conſiderable Force and Snapping, and the Drops which before the Sponge was electrified fall very ſlowly, will now fall very faſt; if the Room be darken'd, theſe

Drops will appear to be *Drops of Fire*, and illuminate the Baſon into which they fall.

Exp. XX.

IF a Capillary Syphon be hung on to the ſmall Cup of Water above-mentioned, at the End of the Barrel, and the Finger laid acroſs the Barrel to prevent the Electric Virtue going to the Water; then before the Water is electrized, you obſerve the Syphon to drop only, and that very gently; but when the Finger is taken off, and the Water becomes electrized, the Syphon runs a Stream; and if the Room be dark, it iſſues from the Syphon in the Appearance of Fire.

Exp. XXI.

A Perſon ſtanding on a Cake of Roſin, with Hand laid on the Gun-Barrel, if a Vein be open'd in his Arm, then (if the Electricity be ſtop'd by the Finger, as above) the Blood will fly out to a certain Diſtance; but when the Finger is taken off, and the Perſon by that Means electrified, the Blood will receive an *Impetus* thereform, and ſpin out with a much greater Velocity, and to a much greater Diſtance than before.

Exp. XXII.

IF a Phial of Water be provided, and well cork'd, and a Wire bended on the Top be pierced thro' the Cork, and thruſt down near the Bottom of the Phial, leaving the upper Part ſtanding about two or three Inches above the Bottle, then laying this Wire on the Globe in Motion, the Wire will receive the Electricity from the Globe, and the Water will be impregnated therewith, the more as the Wire is kept longer on the Globe; then the Perſon thus holding the Phial in one Hand, is to approach a Finger of his other Hand near the middle Part of the Globe, and he will receive the Electric Eruption of Fire with a very conſiderable Snap and Force, greater by much than what proceeds from the Barrel alone; the Reaſon is becauſe all the Electricity running thro' the Wire into the Water, is there condenſed as it were, and confined by the Electric Subſtance of Glaſs, and ſo acts in a greater Quantity, and therefore with a greater Force, than when it iſſues from the Barrel unconfined.

Exp. XXIII.

IN Order to make this Condenſation of the Electric Fire yet greater, the Cork and Top of the Phial is to be cloſed every Way very nicely with Sealing-Wax; and then applied to the Globe, as before, when the Phial of Water has been fully ſaturated with Electricity, the Surplus will immediately iſſue out in wonderful Streams of Purple Fire, thro' ſeveral Pores it finds in the Cork and Wax; and very often in many of theſe Streams which make a beautiful

Appearance in the Room when darken'd, and is a moſt ſingular Phænomenon in Nature.

Exp. XXIV.

IF inſtead of Water we fill the Phial with Quickſilver, the Snap and Force will be ſomewhat greater, but nothing near in Proportion as Mercury is denſer than Water; ſo that the Force of Electric Percuſſion does not appear to depend upon the Quantity of Matter in the percutient Phial, for if it did, the Phial of Mercury muſt give fourteen Times a greater Stroke *(cæteris paribus)* than the ſame ſized Phial of Water, which it does not do, and therefore ſome other Principle of Action ſeems latent in the Subſtance of Bodies.

Exp. XXV.

WHILE the Phial of Mercury is electrizing on the Globe, the Electric Streams will iſſue out of the Sealing-Wax more copiouſly than from the Phial of Water, and will of themſelves ſnap; and theſe Flaſhings and Snappings ſucceed each other ſometimes very faſt, and repreſent, as it it were in Miniature, an *artificial Thundering and Lightning*; and their Phænomenon is peculiar to the *Mercurial Phial*, the Phial of Water never ſnapping of itſelf that I have yet obſerved.

EXP. XXVI.

IF either the Phial of Water or Mercury, when electrized on the Globe, be hung on the Gun-Barrel, the Hand ſtill holding it faſt, then a Finger of the other Hand applied near the Barrel, will draw off a Spark that will give a very ſenſible Snap and Stroke, which will be felt in one or both the Arms, and alſo acroſs the Breaſt; and it is very remarkable, that this Senſation is rather an *uneaſy* than a *painful* one, and goes no farther than the Elbows, in general.

EXP. XXVII.

IF the Electrical Virtue be ſufficiently condenſed in the Phial, by holding the Wire long on the Globe, then the Room being made dark, and the Phial held up with the Hand, the Electric Fire will be ſeen to go off from the Point of the Wire in a ſmall white Flame, which will continue ſome Time; and if a Finger be applied near it, the Wire will emit it with a Snap, but not ſo forcibly as when held on the Globe. And this is the only Way, perhaps, of retaining the Electric Fire, or making its Action temporary. And the Letter from *Paris* ſays, it has been thus retained in the Froſt for 36 Hours together. But I cannot produce any Permanentcy of its Efficacy like that.

Exp. *XXVIII.*

A Perſon ſtanding on a large Cake of Roſin, at leaſt three Inches thick, laying one Hand on the Gun-Barrel, will be electrized, that is, he will be all over poſſeſſed with the Electric Virtue, and at the ſame Time feel nothing of it, unleſs ſome Perſon ſtanding by put his Finger near to any Part, and then the Virtue will be emitted in Form of Fire from any Part, and ſnap, and become very ſenſible to both the Parties, but in a very innocent Manner.

Exp. *XXIX.*

IF the Perſon electrized holds in his Hand a Sword, or any pointed poliſh'd Piece of Iron, and the Room be darken'd, a continual Flame iſſues out of the Point every Way, like that deſcribed in Exp. V. and VI.

Exp. *XXX.*

IF the electrized Perſon hold a ſmall Cup of Water in one Hand as he ſtands upon the Roſin, and with the other takes hold of the Wire in the electrified Phial, and then the Perſon who holds the Phial, by approaching his Finger near the Surface of the Water, will cauſe it to emit the Fire with a more ſenſible Snap and Force, than can be excited without it.

Exp. XXXI.

IF the Perſon ſtanding on the Roſin holds a Piece of Money between his Teeth, and the Wire of the electrified Phial with one Hand; then if the Perſon who holds the Phial touches the Money, the Shock will be very ſenſibly in the Teeth and Head of the electrified Perſon who holds it, and alſo to the other who touches it.

Exp. XXXII.

LET a Perſon ſtand on one Cake of Roſin, and lay one Hand on the Barrel; and let another Perſon ſtand on another Cake by him, and then when the firſt Perſon is throughly electrized, let them both incline their Heads and ſalute each other, and the Fire will join their Lips when nearly touching, and give them a ſmart and mutual Rebuff, which will make them ſeparate more haſtily than they joined: But yet the Pungency is not ſo great as to be very diſagreeable.

Exp. XXXIII.

A Wire fixed on a Pedeſtal, and placed upright in a Baſon of Water, is to be electrified from the Phial above-mentioned, and then the Perſon holding the Phial is to touch the Surface of the Water in the Baſon with the other Hand; the Fire here has a conſiderable

able Effect, but not ſo great as the Letter from *Paris* ſeems to intimate at, leaſt I could never find it ſo.

EXP. XXXIV.

THE Phial being electrified, as above, the whole Company join Hand, or communicate with each other by Wires; then the Operator, or Perſon who ſtands firſt, at one Extremity of the Line, hangs the Electrized Phial on the Barrel, when the Perſon at the other Extremity draws off the Spark from the Barrel; and at that Inſtant all the Company receive the Shock which they feel to their Elbows, and in both their Arms. But I could never yet find thoſe Shocks ſo violent and dangerous as they have been repreſented, tho' they are nearly as great as any Perſon (eſpecially the *Men*) care to endure. This Experiment will equally ſucceed, be the Company never ſo large.

EXP. XXXV.

A Perſon ſtanding on Roſin, with one Hand on the Barrel, points the Finger of the other to the warm Spirits of Wine, and by communicating the Electric Fire thereto, kindles the riſing Fume, and ſo ſets the Whole on Fire. In this Manner, any Sort of Matter, which, when warm'd, will ſend forth an inflamable Vapour, may be thus ſet on Fire.

Exp. XXXVI.

ANOTHER Way to ſet Fire to the Spirit is this; the Perſon holds the Phial of Mercury, or Water, when electrified, on the Barrel with one Hand, and the warm Spirit being put into a Cup or Spoon adapted to the Barrel, and thereby ſtrongly electrized, a Finger of the other Hand being held over and near the Spirit, draws the Electric Spark out of it, and with a Snap ſets the Vapour in a Flame, and conſequently all the Spirit.

Exp. XXXVII.

BECAUSE *Gunpowder*, when heated, emits no inflamable Stream, it cannot be fired by itſelf; but if you mix it with a little inflamable vegetable Oil of any Sort, and grind them a little together, and then put a little into a Spoon, and Heat it, the Vapour will be fired in each of the two Ways above-mention'd for firing the Spirit, and will ſet Fire to the Oil and Powder nearly at the ſame Time, and the Powder will be exploded in the ſame Manner as it uſually is, when wetted. But it may be fired dry, by mixing it with *Camphor*, and reducing both to a Powder, for this will ſend forth an inflamable Vapour, which will be kindled when heated, in either of the Methods above deſcribed.

Exp.

EXP. XXXVIII.

IF a Plate of Tin be adapted to the End of the Barrel, and another be held about two Inches under it with a ſquare or long Piece of Leaf Gold, Braſs, &c. then while the Barrel is electrified the ſaid Piece of Gold will be ſwiftly at firſt attracted and repelled between the two Plates, 'till at laſt the Action between each becoming equal, the Leaf Gold will be ſo equally affected by either, that all its variable Motion will be deſtroyed, and it will appear to be ſuſpended at Reſt between both, and afford a moſt ſurprizing and agreeable Spectacle.

EXP. XXXIX.

IF a ſmall Bell of a Clock be fixed to the End of the Gun-Barrel, and another at four Inches Diſtance on a Pedeſtal of Wood at the ſame Height, and then a ſmall Ivory Ball be ſuſpended by Silken Strings in the Middle between both; the Barrel when electrified will electrize the firſt Bell, and that will attract the Ivory Ball; as it hangs by Silk, which is itſelf electrical, it will retain all the Electric Virtue it receives from the Bell, and therefore will be repell'd from it, and thus be made to ſtrike againſt the other Bell; on this it will diſcharge all its Electricity by Contact, and ſo become again a *Non-Electric*, and in that Caſe will be again attracted by the firſt Bell. And this Effect will be produced alternately, ſo long as the Globe is in Motion; the Conſequence of which is, that the Ivory Ball will be put into conſtant Vibration, and make an *Electrical Pendulum*, which, as it ſtrikes each Bell, it make them ring, and produce one of the moſt agreeable Effects both in the Eye and Ear.

Exp. XL.

IF a ſmall Plate be held under that adapted to the Gun-Barrel, with light Bodies laid upon it, and then a fine Piece of Muſlin or Lawn be interpoſed between both, the electrical Effluvia will not affect the light Bodies, but they will remain undiſturb'd at reſt. For the Electric Virtue will be [illegible] upon the Muſlin, and its Supporter, as [illegible] Bodies, and ſo will not come near the light Bodies to put them in Motion.

Exp. XLI.

IF a *Loadſtone*, arm'd with Iron, be hung on the Gun-Barrel by an Iron Wire, the Electric Virtue will run out from every Part, but more forcibly from the Iron than from the Stone itſelf; from the Stone it ſeems to be emitted in a more lax Manner, and diffuſed in a Sort of Steam or Fiery Vapour; whereas from the Iron it iſſues in a more impetuous, denſe, and penetrating Stream. By this Experiment we ſee the two moſt conſiderable Powers of Nature, *Electricity* and *Magnetiſm*, [illegible] Ways interfere, or impede each other's Action.

Exp. XLII.

IF the Globe be exhauſted of all its Air, and then whirl'd about on the Machine, the Electricity will be obſerved to act wholly within the Globe, where it will appear (in a darken'd Room) in Form of a Cloud or Flame of reddiſh or purple colour'd Light, filling the whole Capacity of the Globe. This viſible Flame will be diminiſh'd, and diſappear by Degrees as the Air is gradually admitted into the Globe. The Reaſon why the Action of the Electric Virtue does not ſhew itſelf outwardly, is the ſtrong repulſive Power of the external Particles of Air encompaſſing the Globe, confining the Electric *Effluvium*, and cauſing it to tend inwards, [illegible] with no Reſiſtance in the vacuous Space [illegible]

F I N I S.